APPENDIX (continued)

030-04308

FORM NRC-313 I
(1-79)
10 CFR 30

U.S. NUCLEAR REGULATORY COMMISSION

APPLICATION FOR BYPRODUCT MATERIAL LICENSE
INDUSTRIAL

See attached instructions for details.

Completed applications are filed in duplicate with the Division of Fuel Cycle and Material Safety, Office of Nuclear Material Safety, and Safeguards, U.S. Nuclear Regulatory Commission, Washington, DC 20555 or applications may be filed in person at the Commission's office at 1717 H Street, NW, Washington, D. C. or 7915 Eastern Avenue, Silver Spring, Maryland.

1. APPLICATION FOR: *(Check and/or complete as appropriate)*

	a. NEW LICENSE
	b. AMENDMENT TO: LICENSE NUMBER
X	c. RENEWAL OF: LICENSE NUMBER 12-13837-01

2. APPLICANT'S NAME *(Institution, firm, person, etc.)*
Standard Oil Company (Indiana)
Amoco Research Center
TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION
(312) 420-5111

3. NAME OF PERSON TO BE CONTACTED REGARDING THIS APPLICATION
Frank J. Piehl or Cindy W. Bloom
TELEPHONE NUMBER: AREA CODE – NUMBER EXTENSION
(312) 420-5068 or (312) 420-5222

4. APPLICANT'S MAILING ADDRESS *(Include Zip Code)*
Attn: Radiation Safety Office F-5
P. O. Box 400
Naperville, IL 60566

5. STREET ADDRESS WHERE LICENSED MATERIAL WILL BE USED *(Include Zip Code)*
See Attachment 5

(IF MORE SPACE IS NEEDED FOR ANY ITEM, USE ADDITIONAL PROPERLY KEYED PAGES.)

6. INDIVIDUAL(S) WHO WILL USE OR DIRECTLY SUPERVISE THE USE OF LICENSED MATERIAL
(See Items 16 and 17 for required training and experience of each individual named below)

	FULL NAME	TITLE
a.	See Attachment 6	
b.		
c.		

7. RADIATION PROTECTION OFFICER
Cindy W. Bloom

Attach a resume of person's training and experience as outlined in Items 16 and 17 and describe his responsibilities under Item 15.

8. LICENSED MATERIAL

LINE NO.	ELEMENT AND MASS NUMBER A	CHEMICAL AND/OR PHYSICAL FORM B	NAME OF MANUFACTURER AND MODEL NUMBER *(If Sealed Source)* C	MAXIMUM NUMBER OF MILLICURIES AND/OR SEALED SOURCES AND MAXIMUM ACTIVITY PER SOURCE WHICH WILL BE POSSESSED AT ANY ONE TIME D
(1)	See Attachment 8			
(2)				
(3)				
(4)				

	DESCRIBE USE OF LICENSED MATERIAL E
(1)	
(2)	
(3)	
(4)	

RECEIVED BY LFMB
Date 6/25/84
Log July 18 RIII
By R/III
Orig. To
Action Compl. Cap

Applicant 422577 IV
Check No. 3260 3K
Amount Fee Category
Type of Fee Ren
Date Check Rec'd 6/25/84
Received By Cap

FORM NRC-313 I (1-79)

10.5-11

8503070500 850201
REG3 LIC30
12-13837-01 PDR

Control No. 76966

Hand delivered 6/19/84 - RIII

9. STORAGE OF SEALED SOURCES

LINE NO.	CONTAINER AND/OR DEVICE IN WHICH EACH SEALED SOURCE WILL BE STORED OR USED. A.	NAME OF MANUFACTURER B.	MODEL NUMBER C.
(1)	See Attachment 9		
(2)			
(3)			
(4)			

10. RADIATION DETECTION INSTRUMENTS

LINE NO.	TYPE OF INSTRUMENT A	MANUFACTURER'S NAME B	MODEL NUMBER C	NUMBER AVAILABLE D	RADIATION DETECTED *(alpha, beta, gamma, neutron)* E	SENSITIVITY RANGE *(milliroentgens/hour or counts/minute)* F
(1)	See Attachment 10					
(2)						
(3)						
(4)						

11. CALIBRATION OF INSTRUMENTS LISTED IN ITEM 10

☐ a. CALIBRATED BY SERVICE COMPANY

NAME, ADDRESS, AND FREQUENCY

See Attachment 11

☐ b. CALIBRATED BY APPLICANT

Attach a separate sheet describing method, frequency and standards used for calibrating instruments.

12. PERSONNEL MONITORING DEVICES

TYPE *(Check and/or complete as appropriate.)* A	SUPPLIER *(Service Company)* B	EXCHANGE FREQUENCY C
☒ (1) FILM BADGE ☒ (2) THERMOLUMINESCENCE DOSIMETER *(TLD)* ☐ (3) OTHER *(Specify)*: ______	R. S. Landauer, Jr., Siemens Gammasonics, Radiation Detection Co., or any dosimetry service certified by an NRC approved or specified laboratory.	☒ MONTHLY ☐ QUARTERLY ☐ OTHER *(Specify)*: ______

13. FACILITIES AND EQUIPMENT (Check were appropriate and attach annotated sketch(es) and description(s).

☒ a. LABORATORY FACILITIES, PLANT FACILITIES, FUME HOODS *(Include filtration, if any)*, ETC. See Attachment 13

☐ b. STORAGE FACILITIES, CONTAINERS, SPECIAL SHIELDING *(fixed and/or temporary)*, ETC.

☐ c. REMOTE HANDLING TOOLS OR EQUIPMENT, ETC.

☐ d. RESPIRATORY PROTECTIVE EQUIPMENT, ETC.

14. WASTE DISPOSAL

a. NAME OF COMMERCIAL WASTE DISPOSAL SERVICE EMPLOYED

See Attachment 14

b. IF COMMERCIAL WASTE DISPOSAL SERVICE IS NOT EMPLOYED, SUBMIT A DETAILED DESCRIPTION OF METHODS WHICH WILL BE USED FOR DISPOSING OF RADIOACTIVE WASTES AND ESTIMATES OF THE TYPE AND AMOUNT OF ACTIVITY INVOLVED. IF THE APPLICATION IS FOR SEALED SOURCES AND DEVICES AND THEY WILL BE RETURNED TO THE MANUFACTURER, SO STATE.

INFORMATION REQUIRED FOR ITEMS 15, 16 AND 17

Describe in detail the information required for Items 15, 16 and 17. Begin each item on a separate page and key to the application as follows:

15. RADIATION PROTECTION PROGRAM. Describe the radiation protection program as appropriate for the material to be used including the duties and responsibilities of the Radiation Protection Officer, control measures, bioassay procedures *(if needed)*, day-to-day general safety instruction to be followed, etc. If the application is for sealed source's also submit leak testing procedures, or if leak testing will be performed using a leak test kit, specify manufacturer and model number of the leak test kit.

16. FORMAL TRAINING IN RADIATION SAFETY. Attach a resume for each individual named in Items 6 and 7. Describe individual's formal training in the following areas where applicable. Include the name of person or institution providing the training, duration of training, when training was received, etc.

    a. Principles and practices of radiation protection.

    b. Radioactivity measurement standardization and monitoring techniques and instruments.

    c. Mathematics and calculations basic to the use and measurement of radioactivity.

    d. Biological effects of radiation.

17. EXPERIENCE. Attach a resume for each individual named in Items 6 and 7. Describe individual's work experience with radiation, including where experience was obtained. Work experience or on-the-job training should be commensurate with the proposed use. Include list of radioisotopes and maximum activity of each used.

18. CERTIFICATE

(This item must be completed by applicant)

The applicant and any official executing this certificate on behalf of the applicant named in Item 2, certify that this application is prepared in conformity with Title 10, Code of Federal Regulations, Part 30, and that all information contained herein, including any supplements attached hereto, is true and correct to the best of our knowledge and belief.

WARNING.–18 U.S.C., Section 1001; Act of June 25, 1948; 62 Stat. 749; makes it a criminal offense to make a willfully false statement or representation to any department or agency of the United States as to any matter within its jurisdiction.

a. LICENSE FEE REQUIRED *(See Section 170.31, 10 CFR 170)* $260	b. CERTIFYING OFFICIAL *(Signature)* Frank J. Piehl c. NAME *(Type or print)* Frank J. Piehl
(1) LICENSE FEE CATEGORY: 1i, 3k	d. TITLE Manager, Analytical Research & Services
(2) LICENSE FEE ENCLOSED: $ 260	e. DATE 6/14/84

FORM NRC-313 I (1-79)

Control No. 76966

Attachment 5

Use Locations of Licensed Material

Laboratories, facilities and job sites of Standard Oil Company (Indiana) where the USNRC maintains jurisdiction for regulating the use of licensed material.

Attachment 6

Individual Who Will Supervise Use

Radioactive materials are to be used by or under the direct supervision of individuals designated by the Radiation Safety Committee, Frank J. Piehl, Chairman.

Attachment 8

Licensed Material

A Element and Mass Number	B Chemical and/or Physical Form	C Manufacturer and Model Number	D Maximum Activity
Any byproduct material with Atomic Numbers 1-83	Any	Not applicable	200mCi each
Any byproduct material with Atomic Numbers 1-83	Irradiated Engine Parts	Not applicable	5Ci total
Hydrogen-3	Any	Not applicable	15Ci
Carbon-14	Any	Not applicable	500mCi
Argon-41	Any	Not applicable	5Ci
Lanthanum-140	Any	Not applicable	1Ci
Hafnium-181	Any	Not applicable	1Ci
Cobalt-60	Sealed sources	Not applicable	20Ci
Strontium-90/ ytrium-90	Sealed sources	Not applicable	2Ci
Cadmium-109	Sealed sources	Not applicable	3mCi each
Cesium-137	Sealed sources	Not applicable	20Ci
Plutonium-238	Sealed sources	Not applicable	30mCi
Americium-241	Sealed sources	Not applicable	1Ci

E. Use of licensed material

Research and Development as defined in 30.4(q) of 10CFR Part 30.

Attachment 9

Radioactive material shall be stored in areas and when appropriate in shielded containers so that radiation levels in UNrestricted areas do not exceed the limits specified in 10CFR20.105.

At temporary job sites, sources will be locked in rooms, cabinets, closets or transport vehicles where the responsible user is reasonably certain adequate security will be maintained. Storage areas will not include residential quarters and will be posted with warning signs as required by 10CFR Part 20.* When appropriate radiation measurements will be made to ensure exposure rates in accessible unrestricted areas do not exceed 2 mR in any one hour or 100 mR in any 7 consecutive days.*

---

*Warning signs and radiation measurements are not required if the transport vehicle is used for storage and the material is packaged in accordance with DOT regulations.

10. Radiation Detection Instruments

Type of Instrument	Manufacturer's Name	Model #	No. Available	Radiation Detected	Sensitivity Range
G.M.	Victoreen	490	2	alpha beta, gamma	0-200mR/hr 0-800,000 CPM
G.M.	Victoreen	495	1	β γ	0-500,000 CPM
G.M.	Nuclear Chicago	2650m	1	α, β, γ	0-100 mR/hr 0-150,000 CPM
Ion Chamber	Victoreen	470A	1	γ	0-1R/hr
G.M.	Baird Atomic	123B	1	α, β, γ	0-99,999 counts
Liquid Scintillation Counter	Beckman	LS-8100	1	β, γ	0-999,999 counts

Attachment 11

Calibration of Instruments

Instruments will be calibrated annually by the Radiation Safety Office, or by Radiation Safety Services, Inc. using the following procedures.

Attachment 11

INSTRUMENTATION CALIBRATION PROCEDURES

A. Traceability of Standards

1. Traceable with 5% accuracy to NBS, DOE or EPA standards.

2. Standards available from national standardizing laboratories of other nations which have been shown by NBS to be in satisfactory agreement with those of the NBS may be utilized. See attached page taken from the 1983 NBS catalogue for further information regarding these types of standards.

3. If a source not traceable as defined in paragraph 1. is used for exposure rate calibrations, its output shall be calibrated using an NBS calibrated MDH 1015C/10x5-180 or Victoreen 570 condenser R meter.

B. Detection (Count Rate) Instruments

1. Pulses from a pulse generator are introduced into the rate meter at the radiation detector connection. Pulses will be similar to those produced by ionizing events.

2. The instrument is adjusted so it is accurate to within ± 20% when measured at two points separated by 35-50% on each scale. Digital instruments and logarithmically scaled instruments will be calibrated near the midpoint of each decade.

3. The detector is attached to the rate meter and exposed to an appropriate radiation source to determine efficiency and verify proper detector function.

4. A record of the calibration will be maintained which contains all the information on the attached form.

C. <u>Exposure and Dose Measurement Instruments</u>

Instruments designed to measure exposure or dose rates will be calibrated in accordance with the following procedure.

1. The instrument is adjusted so it is accurate to within ± 10% when measured at two points separated by 35-50% on each scale. Digital instruments and those with logarithmic scales will be calibrated near the midpoint of each decade.

2. If the accuracy achieved is not within ± 10%, but is within ± 20%, correction factors, charts or graphs will be supplied to the instrument. Instrument scales with greater than 20% error will not be used for measurement purposes.

3. A record of the calibration will be maintained which contains all the information on the attached form.

D. Pocket Dosimeter Calibration

1. The center of the dosimeter is accurately placed at the selected distance from the gamma reference standard. The dosimeters are zeroed before exposure and are read promptly after exposure.

2. Accuracy of each dosimeter is checked at a point in the upper 25% of the dosimeter's range.

3. Charge leakage tests are conducted by placing charged dosimeters in a radiation-free area for at least 24 hours. Initial and final readings are compared.

4. Dosimeters are calibrated so the accuracy varies by no more than 20% and the leakage rate does not exceed 5% of full scale per 24 hours.

GENERAL INFORMATION

Radioactivity Standard Reference Materials (SRM's) are issued by the National Bureau of Standards as part of the Standard Reference Materials Program. A complete list of SRM's is given in NBS Special Publication 260, a catalog published by the Office of Standard Reference Materials (phone 301-921-2045).

Radioactivity SRM's listed in this catalog are prepared in the Radioactivity Group in the NBS Center for Radiation Research. Many of these SRM's are of short half life and are only available at certain announced times. Others of intermediate half life are reissued periodically and may be out-of-stock. If users cannot obtain an NBS Standard Reference Material of a particular radionuclide, the following options should be considered:

Other Government Laboratories

Several useful reference materials are available from other U.S. Government laboratories. Powdered ores, counting samples, and metal samples are available from the New Brunswick Laboratory, U.S. Department of Energy, 9800 South Cass Avenue, Argonne, Illinois 60439. NBL now also distributes for NBS the Special Nuclear Material SRM's. For further information contact 312-972-2453 or 2485.

Standards of many radionuclides are available from the U.S. Environmental Protection Agency laboratory in Las Vegas. For further information contact Arthur Jarvis at 702-798-2103. The full address is given in Appendix 1 along with a list of several calibrated materials that the Radioactivity Group has prepared for the EPA under an interagency agreement.

Commercial Standards Laboratories

Several firms in the United States prepare and distribute standards of radioactivity. The user should ask prospective suppliers if they participate in Measurements Assurance Programs with NBS to ensure that the suppliers' calibrations are traceable to NBS.

In addition to the U.S. firms, National Standardizing Laboratories of other nations offer some standards based on calibrations which have been shown to be in satisfactory agreement with those of the National Bureau of Standards through international intercomparisons.

Calibration Test Services

The Radioactivity Group at NBS offers calibration and measurement services for over 50 radionuclides. There are, however, stringent limitations on the physical and chemical form, and activity levels, of sources which may be submitted. A catalog describing these services is available from the Radioactivity Group. If there is a critical need for a special calibration, it may be possible to arrange it on an "at cost" basis.

PURCHASING INFORMATION

License Certification

Federal regulations require all suppliers of radioactive material to verify, prior to shipment, that the purchaser is authorized to receive the type, form and quantity of material to be transferred. For several standards, indicated by an asterisk in the catalog, NBS does require that a license certification accompany the purchase order. For remaining SRM's, purchasers should check state and

Control No. 7 _ 9 6 6

RADIATION SURVEY INSTRUMENT CALIBRATION RECORD

Manufacturer: ______________________

Model: ______________________

Serial No. ______________________

For:

Calibration No.:

Batteries Replaced: ______________________ Zero: ______________________

Calibration Data

Scale	Field ( )	Reading ( )	Field ( )	Reading ( )

Calibration source: ______________________

Comments, Parts List, Etc.

Calibrated By: ______________________ On: ______________________

Radiation Safety Services, Inc.
827 Simpson, Evanston, IL 60201 (312) 866-7744

Attachment 12

Personnel Monitoring Program

Dosimetry

Film or TLD whole body and/or TLD extremity dosimeters are provided to the following people:

A. Persons who have a reasonable probability of receiving more than 25% of the exposure limit set forth in 10CFR20.101(a).

B. Persons who work with significant quantities of hard beta, X-ray or gamma emitters.

C. Persons who request dosimeters because of personal concern.

Attachment 13

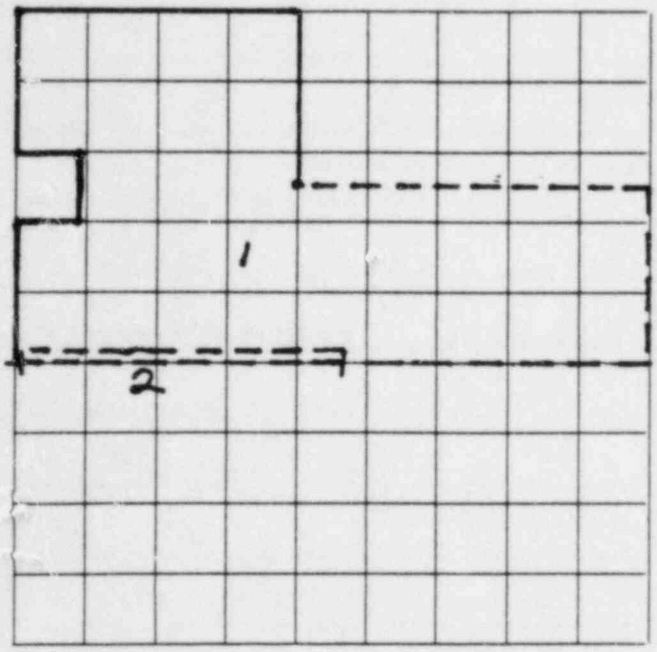
Typical Facilities

SURVEY REPORT

BUILDING: 600 ROOM: 97 DATE: ______ BY: ______

Routine ☐ Spot Check ☐ Special ☐ Equipment ☐

Survey Instrument ______ ______ Source of Ionizing Radiation



TYPE	FORM	ACTIVITY

Ventilation: ______

Comments: ______

SURVEY FINDINGS

AREA	cpm		
1 Floor			
2 sliding door			

Background

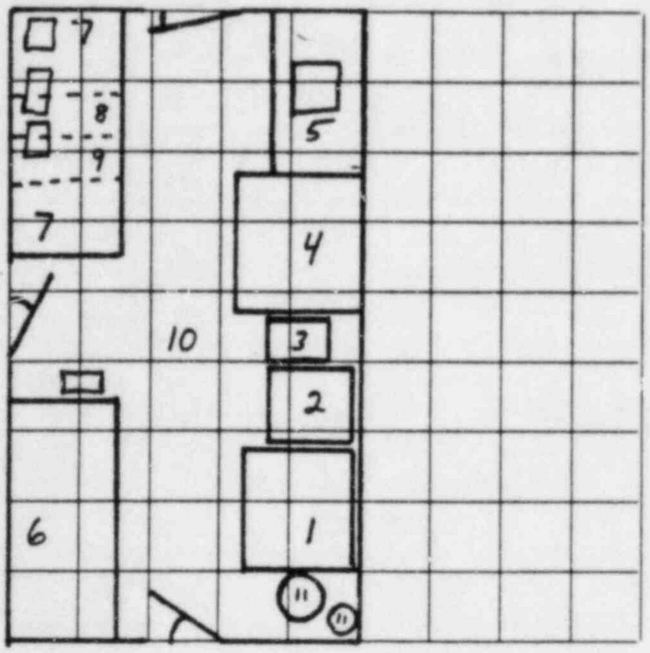
RECOMMENDATIONS: ______

SURVEY REPORT

BUILDING: 600 ROOM: 3038 DATE: ____________ BY: ____________

Routine ☐ Spot Check ☐ Special ☐ Equipment ☐

Survey Instrument ______________________ Source of Ionizing Radiation



TYPE	FORM	ACTIVITY

Ventilation: ____________

Comments: ____________

SURVEY FINDINGS

AREA	cpm		
1 Liquid Scintillation Counter 2 Incubater/Shaker			
3 Oven 4 Hood			
5 Workbench w sink 6 Workbench			
7 Workbench w shaker, Autoclave, auto temp. 8 Refrigerator			
9 Freezer 10 Floor			
11 Radioactive Waste drums			

Background

RECOMMENDATIONS: ____________

Radiation Safety Services, Inc.
827 Simpson, Evanston, IL 60201 (312) 866-7744

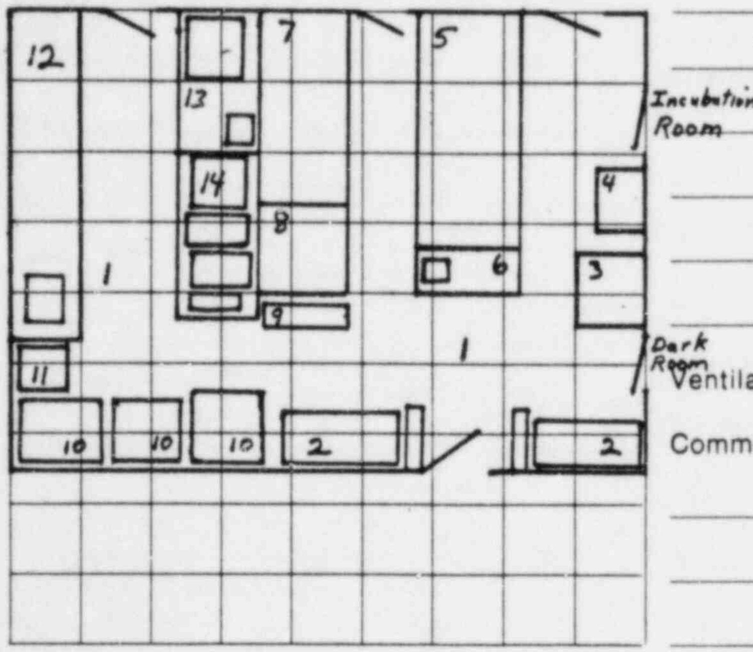
Control No. 76966

SURVEY REPORT

BUILDING: 600 ROOM: 3542 DATE: ______ BY: ______

Routine ☐ Spot Check ☐ Special ☐ Equipment ☐

Survey Instrument ______ Source of Ionizing Radiation



TYPE	FORM	ACTIVITY

Ventilation: ______

Comments: ______

SURVEY FINDINGS

AREA	cpm		
1 Floor			
2 Desks			
3 Incubator			
4 Refrigerator			
5 Workbench			
6 Sink + Bench			
7 Hood			
8 Workbench			
9 Shelves			
10 Centrifuges			
11 Shelves			
12 Workbench			
13 Workbench w Spectrophotometer + shelves			
14 Hood w Shakers, H_2O bath, sonifier			

Background

RECOMMENDATIONS: ______

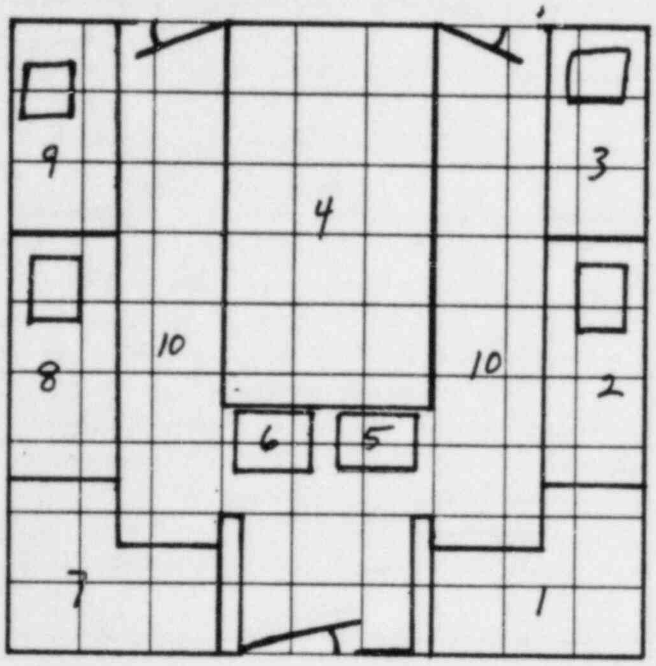
Radiation Safety Services, Inc.
827 Simpson, Evanston, IL 60201 (312) 866-7744

SURVEY REPORT

BUILDING: 600 ROOM: 3543 DATE: ______ BY: ______

Routine ☐ Spot Check ☐ Special ☐ Equipment ☐

Survey Instrument ______ Source of Ionizing Radiation



TYPE	FORM	ACTIVITY

Ventilation: ______

Comments: ______

SURVEY FINDINGS

AREA	cpm		
1 Desk			
2 Workbench w Sink			
3 Hood w oven			
4 Workbench			
5 Freezer			
6 Refrigerator			
7 Desk			
8 Workbench w Sink			
9 Hood w Incubator			
10 Floor			

Background

RECOMMENDATIONS: ______

Radiation Safety Services, Inc.
827 Simpson, Evanston, IL 60201 (312) 866-7744

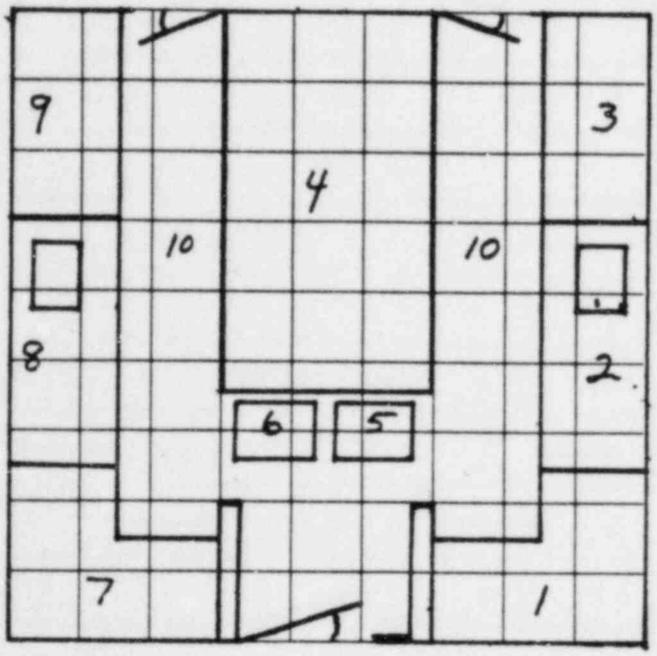
Control No. 76966

SURVEY REPORT

BUILDING: 600 ROOM: 3544 DATE: ______ BY: ______

Routine ☐ Spot Check ☐ Special ☐ Equipment ☐

Survey Instrument ______ Source of Ionizing Radiation



TYPE	FORM	ACTIVITY

Ventilation:

Comments:

SURVEY FINDINGS

AREA	cpm		
1 Desk			
2 Workbench w Sink			
3 Hood			
4 Workbench			
5 Refrigerator + Shelves			
6 Refrigerator			
7 Desk			
8 Workbench w Sink			
9 Hood			
10 Floor			

Background

RECOMMENDATIONS:

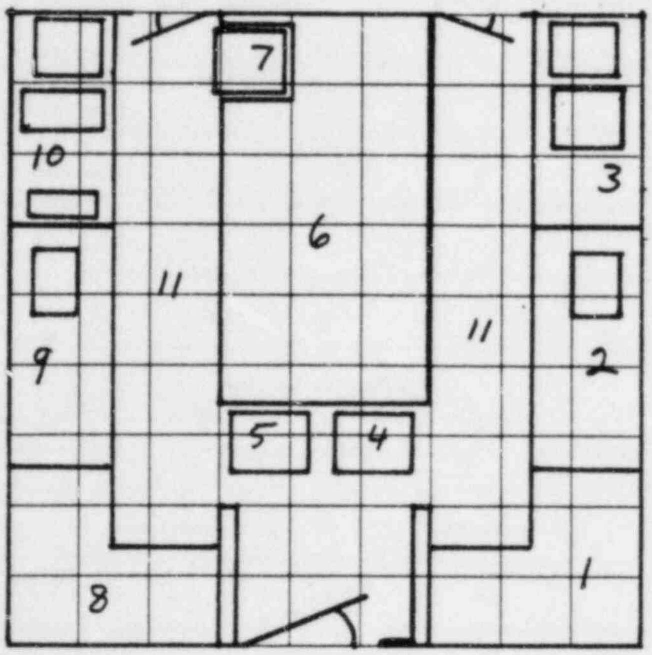
Radiation Safety Services, Inc.
827 Simpson, Evanston, IL 60201 (312) 866-7744

SURVEY REPORT

BUILDING: 600 ROOM: 3546 DATE: ________ BY: ________

Routine ☐ Spot Check ☐ Special ☐ Equipment ☐

Survey Instrument ____________________ Source of Ionizing Radiation



TYPE	FORM	ACTIVITY

Ventilation: ____________________

Comments: ____________________

SURVEY FINDINGS

AREA	cpm		
1 Desk			
2 Workbench w Sink			
3 Hood w Centrifuge, shaker			
4 Refrigerator			
5 Refrigerator + Shaker			
6 Workbench			
7 Centrifuge			
8 Desk			
9 Workbench w Sink			
10 Hood w Oven, H_2O bath, Condensation Trap			
11 Floor			

Background

RECOMMENDATIONS: ____________________

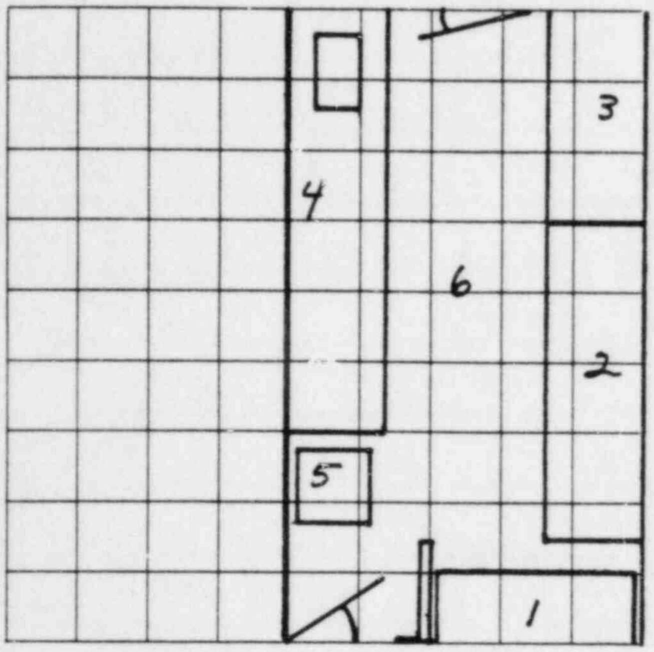
Radiation Safety Services, Inc.
827 Simpson, Evanston, IL 60201 (312) 866-7744

SURVEY REPORT

BUILDING: 600 ROOM: 3549 DATE: ______ BY: ______

Routine ☐ Spot Check ☐ Special ☐ Equipment ☐

Survey Instrument ______ Source of Ionizing Radiation



TYPE	FORM	ACTIVITY

Ventilation: ______

Comments: ______

SURVEY FINDINGS

AREA	cpm		
1 Desk			
2 Workbench			
3 Hood			
4 Workbench w sink			
5 Refrigerator			
6 Floor			

Background

RECOMMENDATIONS: ______

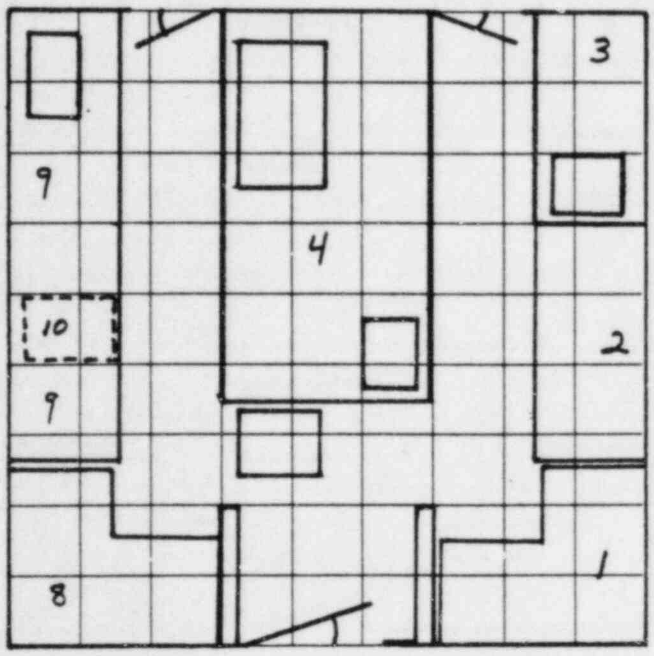
Radiation Safety Services, Inc.
827 Simpson, Evanston, IL 60201 (312) 866-7744

SURVEY REPORT

BUILDING: 600 ROOM: 3550 DATE: ______ BY: ______

Routine ☐ Spot Check ☐ Special ☐ Equipment ☐

Survey Instrument ______ Source of Ionizing Radiation



TYPE	FORM	ACTIVITY

Ventilation: ______

Comments: ______

SURVEY FINDINGS

AREA	cpm		
1 Desk 2 Work bench			
3 Hood w H_2O bath 4 Work bench			
5 Hood 6 Centrifuge			
7 Incubators 8 Desk			
9 Work bench w Sink 10 Refrigerator			
11 Floor			

Background

RECOMMENDATIONS: ______

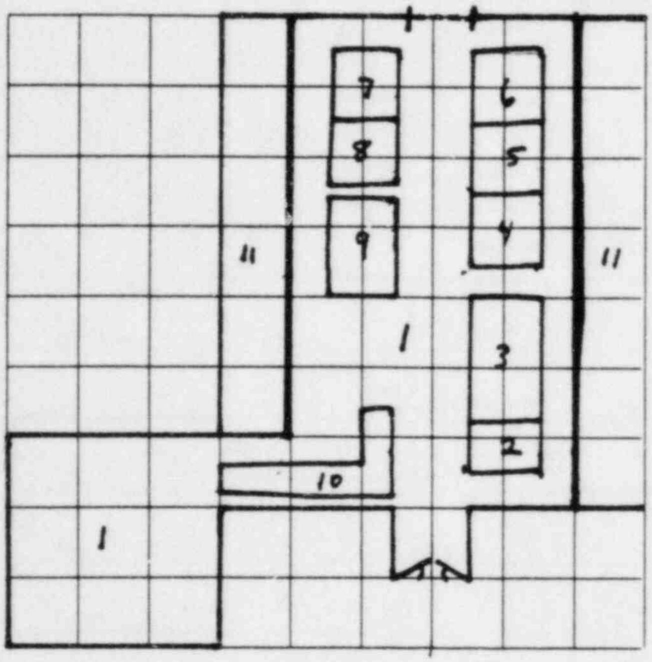
Radiation Safety Services, Inc.
827 Simpson, Evanston, IL 60201 (312) 866-7744

SURVEY REPORT

BUILDING: 700 ROOM: High-Bay DATE: ____________ BY: ____________

Routine ☐ Spot Check ☐ Special ☐ Equipment ☐

Survey Instrument ______________________________ Source of Ionizing Radiation



TYPE	FORM	ACTIVITY

Ventilation: ______________________

Comments: ______________________

SURVEY FINDINGS

AREA	cpm		
1 Floor			
2 Cell # 57			
3 Cell # 80			
4 Cell # 92			
5 Cell # 85			
6 Cell # 61			
7 Cell # 69			
8 Cell # 68			
9 Cell # 77			
10 Cell			
11 Instrument, Monitoring Rooms			

Background

RECOMMENDATIONS: ______________________

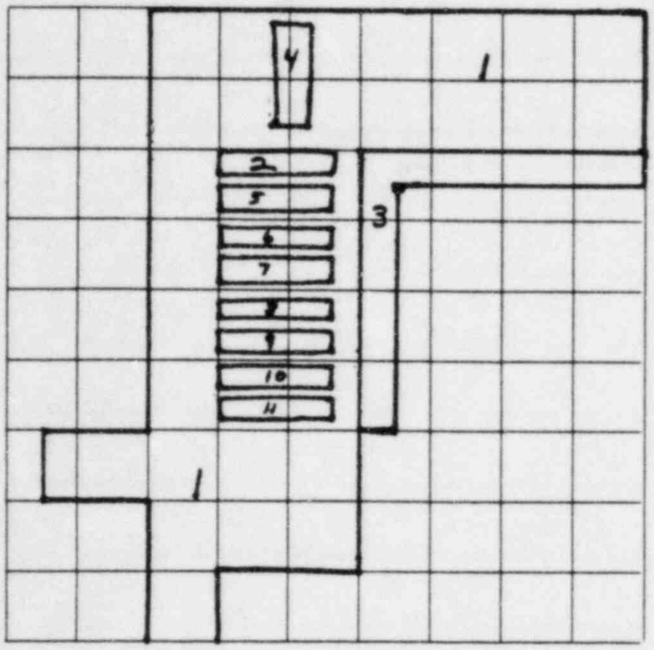
Radiation Safety Services, Inc.
827 Simpson, Evanston, IL 60201 (312) 866-7744

SURVEY REPORT

BUILDING: 700 ROOM: Low-Bay DATE: ______ BY: ______

Routine ☐ Spot Check ☐ Special ☐ Equipment ☐

Survey Instrument ______ Source of Ionizing Radiation



TYPE	FORM	ACTIVITY

Ventilation: ______

Comments: ______

SURVEY FINDINGS

AREA	cpm		
1 Floor			
2 Cell #15 & #56 w Radioactive Gage			
3 Instrument & Monitoring Area			
4 Cell # 49 & #50			
5 Cell #34 & #35			
6 Cell #36 & #37			
7 Cell # 40 & 41			
8 Cell #31			
9 Cell # 2			
10 Cell #45			
11 Cell # 38			

Background

RECOMMENDATIONS: ______

Radiation Safety Services, Inc.
827 Simpson, Evanston, IL 60201 (312) 866-7744

Control No. 7696

Attachment 14

Radioactive Waste Disposal

Radioactive waste will be disposed of in the following ways:

1. Transfer to persons licensed to receive such material.

2. Release to air in conformance with 10CFR10.106.

3. Release to a sanitary sewer in conformance with 10CFR20.303.

4. Release to ordinary waste after decay in storage, and following a survey performed with a low-level laboratory survey instrument resulting in readings indistinguishable from background radiation and removal of radiation warning labels.

5. By incorporation in exempt concentrations into products or materials pursuant to 10 CFR 32.11. Reports will be filed pursuant to 10 CFR 32.12. (See following)

INCORPORATION IN EXEMPT CONCENTRATIONS

Introduction of byproduct material in exempt concentrations into products or materials, and transfer of ownership or possession pursuant to 10 CFR 32.11.

- Description of material introduced

  a. Liquids - H-3 or C-14
     Tagged organic molecules of the similar chemical structure as the material tested.

  b. Solids -
     Rare earths, e.g., La-140 chemically similar to material tested.

- Intended use of byproduct material

  a. & b.
     To study flow characteristics.

- The product or material into which it is introduced

  a. Refinery intermediates and final products.

  b. Decanted oil and catalytic cracking catalyst.

- Method of introduction

  a. Example - C-14 labeled benzene is injected into a feed line of a desulferization unit.

  b. Example - lanthanum chloride impregnated on small amounts of catalyst is injected into the fluid catalytic cracking unit. (FCU)

- Initial concentration of byproduct material

  a. For H-3 and C-4 compounds calculations will be performed prior to introduction, to assure that sufficient dilution occurs to meet NRC release limits, specified in 10 CFR 30.70. For example, samples of C-14 labeled benzene, cyclohexane, decane or cetane are injected into a feed line of a desulfurization unit, over a period of 12 hours, resulting in a total activity of 20 mCi in 10,000 barrels of fuel oil. This results in an initial concentration of:

$$\frac{20 \text{ mCi} \times 10^3 \frac{\text{uCi}}{\text{mCi}}}{10{,}000 \text{ barrel} \times 55 \frac{\text{gal}}{\text{barrel}} \times 3.79 \frac{1}{\text{gal.}} \times \frac{10^3 \text{ ml}}{1}} = 9.6 \times 10^{-6} \frac{\text{uCi}}{\text{ml}}$$

  b. Estimated initial concentrations of La-140 used in our Salt Lake refinery in 1974 were 3×10^{-5} uCi/ml in the decanted oil (this assumes 10 percent of all La-140 injected into the FCU dissolves in the decanted oil) and 4×10^{-4} uCi/ml in the catalytic cracking catalyst.

- Control methods

a. & b. To assure that no more than the specified amount of material is introduced into the product, the activity of the sample to be injected will be measured prior to injection using appropriate instrumentation.

- Estimated time interval between introduction and transfer

a. Not applicable for H-3 and C-14.

b. In the example above the time interval before transfer of the decanted oil was several hours, transfer the catalytic cracking catalyst occurred 48 hours after introduction.

- Estimated concentration of the radioisotope in the product at the time of transfer

At the time of transfer concentrations of byproduct material will not exceed the concentrations specified in 10 CFR 30.70.

a. In the C-14 example above the estimated concentration in the final product is 1.06×10^{-5} uCi/ml, which is less than 8×10^{-3} uCi/ml specified for C-14 in 10 CFR 30.70.

b. For the La-140 example the estimated final concentration in the decanted oil is 3×10^{-6} uCi/ml, due to dillution of the oil, and 2×10^{-4} uCi/ml in the catalytic cracking catalyst, due to decay of the La-140. The limit specified in 10 CFR 30.70 is 2×10^{-4} uCi/ml.

- It is not likely that these refinery intermediates and products will be incorporated in any food, beverage, cosmetic, drug or other commodity or product designed for ingestion or inhalation by, or application to, a human being. Calculations will be made to determine lowest concentrations feasible for use, in accordance with the ALARA philosophy.

- Records will be filed pursuant to 10 CFR 32.12.

Attachment 15

Radiation Protection Program

Radiation Safety Committee

The Radiation Safety Committee will advise management on specific needs and policies in all areas of radiation protection and usage, and will have the responsibility and the authority to approve, disapprove, modify, suspend or terminate authorization for the use of radiation sources. The Committee will grant authorization to individuals who satisfy the requirements in 10CFR33.15(b)(1) and (2).

The Radiation Safety Committee will include the Radiation Safety Officer (RSO), the Radiation Safety Committee Chairman, the Safety Officer, the Industrial Hygienist and other scientists and/or engineers from Amoco Research Center.

The Radiation Safety Committee will review, evaluate and either approve or disapprove individual applications to use radioactive material. The review and evaluation will be based upon a written description of facilities and equipment procedures, a written protocol and a training and experience statement for the applicant. The Committee will consider the recommendation made by the Radiation Safety Officer (RSO) based upon an interview with a new applicant and a review of facilities. Where an applicant is already an authorized user, the RSO may give temporary approval for a new use of radioactive material if the new use does not represent a significant change in the level of hazard in a laboratory. This temporary approval will be subject to final review and approval or disapproval by the Radiation Safety Committee. Where an applicant requests an increase in his individual possession limit, the RSO may give final approval if in his judgement there is no significant increase in hazard in a laboratory. The forms used for application are attached.

The Committee will meet at least once per calendar quarter to discuss radiation safety problems relating to the use of by-product material and other sources of radiation. A quorum should consist of the Chairman of the Committee, the RSO and at least two other members. To expedite handling, requests for authorization may be circulated by mail to the Committee members.

Approval, whether by mail circulation or a Committee meeting, will require action by 2/3 of the total committee. This 2/3 must include the RSO and the Chairman of the Radiation Safety Committee.

Copies of the Committee minutes and records of Committee action are maintained on a continuing basis by the Radiation Safety Officer.

The current composition of the Radiation Safety Committee follows.

CORRECTIVE ACTION PROCEDURE ON VIOLATIONS OF RULES OF HOT LAB CONDUCT

1. The objective of the Radiation Safety Program is to ensure that radioactive materials are used in a manner assuring the least practicable exposure of individuals to radiation. To achieve this, radioactive materials must be used in accordance with established standards. These standard rules, based on NRC regulations, place simple restraints upon the use of radioactive materials so as to minimize both exposure from radiation and the possibility of accidental ingestion of radioactive materials.

a. The Rules of Hot Lab Conduct, which are incorporated into our NRC broad license, are to be posted in every radionuclide using laboratory . Each authorized user as part of his authorization is expected to follow the rules. Adherence to the rules is routinely checked in surveys performed by the Radiation Safety Office.

b. If serious violations of the rules are noted during a survey, a copy of the violation report is mailed to the authorized user, another copy is posted by the Radiation Safety Office along with the survey in the laboratory, and a copy is sent to the Radiation Safety Committee for its consideration.

c. When repeated violations occur, the Radiation Safety Officer shall meet with the authorized user, in whose laboratory the repeated violations have occurred, and discuss the importance of correcting the errors. This meeting shall be documented, and the Radiation Safety Committee shall be sent verification that the authorized user was informed of the repeated violation.

d. If repeated violations continue to occur, the Radiation Safety Committee will review the authorized user's status and recommend ~~to the Director~~ remedial actions such as:

(1) Denying future requests for authorization.

(2) Directing the Radiation Safety Officer to disallow any requests for purchase of radioactive materials by the authorized user in whose laboratories the violations have occurred.

(3) Suspending the user's authorization, requiring that all work with radioactive materials in the laboratory cease.

(4) Terminating the user's authorization permanently. If this step is taken, the Radiation Safety Officer will be directed to remove all radioactive materials from the laboratory.

e. Recommendation and action taken by the committee shall be communicated in writing by the Chairman of the Radiation Safety Committee to the authorized users, and shall be subject to appeal to the committee by the authorized user. The severity of the committee action will be consistent with the risks and hazards associated with the usage of radioactive materials in the violating laboratories. Every effort shall be made to minimize the inconvenience to authorized users while assuring maximum compliance with the Rules of Hot Lab Conduct.

Members of Radioisotope & Radiation Safety Committee
June 1, 1984

Name	Position
F. J. Piehl	Chairman, R&D Radioisotope & Radiation Safety Committee. Manager, Analytical Research & Services, Standard Oil Company (Indiana), Naperville, Illinois. F. J. Piehl received his Ph.D in Organic Chemistry from the University of Chicago in 1952. Since that time, he has held various research and supervisory positions in the R&D departments of Standard Oil Company (Indiana) and Amoco Oil Company. Eight years on the Radioisotope & Radiation Safety Committee.
R. M. Chaney	Staff Research Engineer, Materials Research & Services, Standard Oil Company (Indiana), Naperville, Illinois. Extensive experience in non-destructive testing. Presently training consultant in Industrial Radiography. Three years on the Radioisotope & Radiation Safety Committee.
M. Finn	Senior Industrial Hygienist for the Amoco Research Center. Certified in Comprehensive Practice by the American Board of Industrial Hygiene. Doctor of Philosophy in Public Health Sciences from the University of Illinois at Chicago. Four years as a Compliance Officer with the U. S. Department of Labor, Occupational Safety & Health Administration.
R. T. Hawkins	Research Physicist, Integrated Materials, Corporate Research, Standard Oil Company (Indiana), Naperville, Illinois. Received Ph.D in Physics in 1977, Stanford University in laser spectroscopy. Seven years experience in lasers. Three years on the Radioisotope & Radiation Safety Committee.
G. S. Kovener	Senior Research Physicist, Exploratory Research, Amoco Chemicals Corporation, Naperville, Illinois. Past training and experience in quantum chemistry, FAR infrared, neutron diffraction, and RF plasma processing. Member of Laser Safety Committee. Four years on the Radioisotope & Radiation Safety Committee.
D. Lewis	Senior Research Chemist, Group Leader Integrated Materials, Physical Technology Division, Corporate Research, Standard Oil Company (Indiana), Naperville, Illinois. Twelve years on the Radioisotope & Radiation Safety Committee.

Name	Position
B. L. Meyers	Senior Research Associate, X-ray Diffraction and Catalyst Characterization, Analytical Research & Services, Standard Oil Company (Indiana), Naperville, Illinois. Twelve years on the Radioisotope & Radiation Safety Committee.
J. R. Plant	Supervisor, Environmental Affairs & Safety, Amoco Research Center, Naperville, Illinois. Two years on the Radioisotope & Radiation Safety Committee.
R. L. Stoffer	Senior Research Environmental Health Chemist, Environmental Affairs & Safety, Standard Oil Company (Indiana), Naperville, Illinois. Radiological Safety Officer, Research Department, Standard Oil Company (Indiana), 1956-1975; substitute RSO, 1975 to present. Research in the application of radioisotopes in petroleum and petrochemical research, 1956-1972. Twenty years on the Radioisotope & Radiation Safety Committee.
E. Watson	Research Supervisor, Instrument Services, Standard Oil Company (Indiana), Naperville, Illinois. Three years radiation experience, Radiation Laboratory, University of Notre Dame. Six years on the Radioisotope & Radiation Safety Committee.

mc
MC3:R&R
Pages 10-11

Radiation Safety Officer

The Radiation Safety Officer, who reports to the Chairman of the RS', has the responsibility for the day-to-day operation of the Radiation Safety Program, and has the authority to alter, modify, suspend or terminate any use of radioactive materials or radiation producing equipment where there is an imminent hazard. The Radiation Safety Officer is also responsible for review and maintenance of all records and documents necessary for compliance with regulations and license conditions and makes recommendations regarding policy and operations.

The Radiation Safety Officer is available on site to perform the duties and meet the responsibilities necessary to comply with regulations and license conditions. When not on site the Radiation Safety Officer can be reached by long distance page within 15 minutes, and can be on site within 45 minutes during working hours, and 1 hour 15 minutes during nonworking hours.

TRAINING

A. Housekeeping and Security personnel will be given a minimum of one hour of training in operations in restricted areas and appropriate actions to be taken during normal operations and during emergencies.

B. Staff who use radioactive materials as part of their assigned activity are given a minimum of six hours of training in the following subjects:

1. Compliance with Federal, State and Center rules and regulations governing the uses of radioactive materials.

2. The principles and practices of radiation safety.

3. Radioactivity measurements, standardization, monitoring and instrument techniques.

4. Mathematics and calculations basic to the use or measurement of radioactivity.

5. Biological effects of radiation.

6. The safe handling of radioactive materials and Center procedures.

C. Prospective authorized users must receive the above training and have a further week of on the job training in the handling of radioactive materials similar in nature to the materials with which they will be working. This will be obtained under the supervision of a previously authorized user.

MATERIAL CONTROL

Total individual possession limits for each isotope are controlled so that they do not exceed possession limits. Each individual's inventory is controlled so that it does not exceed his possession limit for each isotope. Transfer of radioactive material within the Center and to persons outside the Center are performed by the Radiation Safety Office. When a transfer is made outside the Center, a copy of the recipient's license is required to verify that the person receiving the material is authorized to do so.

Acquisition, inventory and disposal of material within the Center are controlled using the following system:

1. The authorized user prepares a separation requisition for each individual isotope shipment, i.e., one isotope per form.

2. The requestor calls the Radiation Safety Office for approval to submit the purchase order.

3. The Radiation Safety Office checks that the requestor is an authorized user, that he is authorized for the isotope requested and that the isotope activity is within his possession limit.

4. The Radiation Safety Office gives the requestor radioactive inventory numbers for approved purchases. The Radiation Safety Office initiates the Radioactive Material Control Form (attached) and files it pending receipt of the shipment.

5. Packages are delivered to the Radiation Safety Laboratory by the Shipping and Receiving Department during normal working hours. Off-hour shipments are received by the Security Department. Specific instructions will be given in writing to security personnel regarding the receipt of radioactive packages.

6. Upon receipt of the shipment, the Radiation Safety Office checks the package for contamination, evaluates the accuracy of the documentation on the shipment and matches the shipment with the Radioactive Material Control Form.

7. At this time, the Radiation Safety Office checks the authorized user's on hand activity to determine whether or not the on hand activity plus the new shipment will exceed his possession limit. If the total is in excess of the individual's possession limit, the Radiation Safety Office retains possession of the shipment giving the authorized user the opportunity to dispose of enough on hand activity to bring him within his possession limit or to demonstrate that proper disposal has taken place.

8. If the authorized user's possession limit is not exceeded by the new shipment, the radioactive material is delivered to the appropriate laboratory along with two copies of the Radioactive Material Control Form. One copy of the form is to be retained in the authorized user's records. The second copy is to be returned to the Radiation Safety Office when the material from that shipment has been properly processed for disposal.

9. Upon receipt of the "disposal" copy of the Radioactive Material Control Form, the Radiation Safety Office checks the form against the individual user's record and reduces his on hand activity by the specified amount.

CONTROL NO ____________

DATE ____________

RADIATION SAFETY SERVICES, Inc.
RADIOACTIVE MATERIAL CONTROL FORM

LICENSEE ____________

AUTHORIZED USER ____________

BUILDING ____________ LABORATORY ____________

ISOTOPE ____________ ACTIVITY ____________ FORM ____________

COMPANY ____________ P.O. No. ____________

MATERIAL RECEIVED: DATE ____________ CONTAMINATION INSPECTION ____________

DATE	ACTIVITY BALANCE (mCi.)	REDUCTION BY DECAY OR DISPOSAL (mCi.)	NOTES

Please return the pink copy of this form to Radiation Safety when less than 1% of the original activity remains. This purchase will remain on your inventory record until the copy is returned. Keep the yellow copy for your records.

Date pink copy returned ____________

Control No. 76966

INSTRUCTIONS FOR INSPECTING PACKAGES

1. Don disposable gloves while processing the package. Radionuclide solutions inadvertently stored upside down during shipment may have leaked, resulting in radioactive contamination.

2. Wipe test the outside of the package for removable surface contamination. Take appropriate steps for contamination control if necessary. If contamination exceeds the following limits, contact the Radiation Safety Officer or his delegate immediately.

Beta-gamma emitters, natural or depleted uranium, or natural thorium	$2.2x10^4$dpm/100cm^2
Other alpha emitting nuclides	$2.2x10^3$dpm/100cm^2

   Wipe tests need not be done for gaseous sources or for packages not requiring labeling (exempt quantities) or for packages containing material distributed to individuals exempt from license.

3. Open package and check for possible breakage in seals or containers, loss of liquid or change in color of absorbing materials.

4. Verify that the package contents are as described on the packing list.

5. Match the packing list with the proper Radioactive Material Control Form, complete the form and return it to the inventory binder.

6. For sealed source receipts, if the source requires leak testing and a current leak test certificate was not provided by the supplier, a leak test must be performed before use.

7. If the material is not put to use, store the material as necessary, e.g., in the hood, refrigerator or freezer.

8. Promptly report any discrepancies or irregularities to the Radiation Safety Officer or his delegate.

CONTROL OF AIRBORNE RADIOACTIVITY
IN UNRESTRICTED AREAS

Volatile and gaseous radioactive materials are usually used in hoods or glove boxes. Venting is to an unrestricted area. Prior to venting, calculations can be performed to ensure that the concentration of the effluent is within the regulatory limits. A typical calculation is shown below.

For an experiment using a volatile form of I-131 in a glove box vented to an unrestricted area where the expected release is 1/10 of a uCi per day, we would calculate the following air flow so as to meet the requirements in Column 1, Table 2, Appendix "B", Part 20. If the work is conducted 50 weeks of the year, we have a release of 5 x 0.1 uCi x 50 = 25 uCi of I-131. The volume of air necessary to dilute this activity to minimum acceptable limits is 25 uCi $\div$ 10^{-10} uCI per cc which equals 2.5 x 10^{11} cc or 8.829 x 10^{6} cubic feet per year which is 16.8 cubic feet per minute (24 hour operations).

SURVEYS

Routine Surveys

Surveys will be performed on a regular schedule. Laboratories using radioactive materials in unsealed form will be surveyed for surface contamination and, if appropriate, external exposure rates. Laboratories using sealed sources will be surveyed for external exposure rates when appropriate.

In low background areas direct surface contamination surveys will be performed using equipment capable of detecting the radionuclides being used. Where surface contamination is found to exceed the limits in the table for fixed contamination and in high background areas a surface wipe will be made to determine if the activity is removable. Survey results are entered on the survey report form.

Radionuclides not included in the tables will be placed in a group having a comparable rating of toxicity.

Records of surveys are evaluated by the Radiation Safety Officer or his delegate and retained in the Radiation Safety Office.

Survey frequencies are based on the system of classification found in the recommendations of the International Commission of Radiology Protection, Report of Committee V; Pergamon Press, New York, New York (1965).

The attached Tables I and II are reproduced directly from ICRP Report V. Laboratories classified as low level will be surveyed quarterly, those classified as medium level will be surveyed monthly and those classified as high level will be surveyed weekly.

SURVEY REPORT

BUILDING: ____________ ROOM: ____________ DATE: ____________ BY: ____________

Routine ☐ Spot Check ☐ Special ☐ Equipment ☐

Survey Instrument ______________________ Source of Ionizing Radiation

TYPE	FORM	ACTIVITY

Ventilation: ______________________

Comments: ______________________

SURVEY FINDINGS

AREA			

Background

RECOMMENDATIONS: ______________________

Radiation Safety Services, Inc.
827 Simpson, Evanston, IL 60201 (312) 866-7744

according to relative radiotoxicity. Such a classification, based on one drawn up by the International Atomic Energy Agency*, is given in Table 1 below†.

TABLE 1. CLASSIFICATION OF ISOTOPES ACCORDING TO RELATIVE RADIOTOXICITY PER UNIT ACTIVITY

Group 1‡								
Pb-210	Po-210	Ra-223	Ra-226	Ra-228	Ac-227	Th-227	Th-228	Th-230
Pa-231	U-230	U-232	U-233	U-234	Np-237	Pu-238	Pu-239	Pu-240
Pu-241	Pu-242	Am-241	Am-243	Cm-242	Cm-243	Cm-244	Cm-245	Cm-246
Cf-249	Cf-250	Cf-252						
Group 2‡								
Na-22	Cl-36	Ca-45	Sc-46	Mn-54	Co-56	Co-60	Sr-89	Sr-90
Y-91	Zr-95	Ru-106	Ag-110m	Cd-115m	In-114m	Sb-124	Sb-125	Te-127m
Te-129m	I-124	I-126	I-131	I-133	Cs-134	Cs-137	Ba-140	Ce-144
Eu-152 (13 y)		Eu-154	Tb-160	Tm-170	Hf-181	Ta-182	Ir-192	Tl-204
Bi-207	Bi-210	At-211	Pb-212	Ra-224	Ac-228	Pa-230	Th-234	U-236
Bk-249								
Group 3‡								
Be-7	C-14	F-18	Na-24	Cl-38	Si-31	P-32	S-35	A-41
K-42	K-43	Ca-47	Sc-47	Sc-48	V-48	Cr-51	Mn-52	Mn-56
Fe-52	Fe-55	Fe-59	Co-57	Co-58	Ni-63	Ni-65	Cu-64	Zn-65
Zn-69m	Ga-72	As-73	As-74	As-76	As-77	Se-75	Br-82	Kr-85m
Kr-87	Rb-86	Sr-85	Sr-91	Y-90	Y-92	Y-93	Zr-97	Nb-93m
Nb-95	Mo-99	Tc-96	Tc-97m	Tc-97	Tc-99	Ru-97	Ru-103	Ru-105
Rh-105	Pd-103	Pd-109	Ag-105	Ag-111	Cd-109	Cd-115	In-115m	Sn-113
Sn-125	Sb-122	Te-125m	Te-127	Te-129	Te-131m	Te-132	I-130	I-132
I-134	I-135	Xe-135	Cs-131	Cs-136	Ba-131	La-140	Ce-141	Ce-143
Pr-142	Pr-143	Nd-147	Nd-149	Pm-147	Pm-149	Sm-151	Sm-153	Eu-152 (9.2 hr)
Eu-155	Gd-153	Gd-159	Dy-165	Dy-166	Ho-166	Er-169	Er-171	
Tm-171,	Yb-175	Lu-177	W-181	W-185	W-187	Re-183	Re-186	Re-188
Os-185	Os-191	Os-193	Ir-190	Ir-194	Pt-191	Pt-193	Pt-197	Au-196
Au-198	Au-199	Hg-197	Hg-197m	Hg-203	Tl-200	Tl-201	Tl-202	Pb-203
Bi-206	Bi-212	Rn-220	Rn-222	Th-231	Pa-233	Np-239		
Group 4‡								
H-3	O-15	A-37	Co-58m	Ni-59	Zn-69	Ge-71	Kr-85	Sr-85m
Rb-87	Y-91m	Zr-93	Nb-97	Tc-96m	Tc-99m	Rh-103m	In-113m	I-129
Xe-131m	Xe-133	Cs-134m	Cs-135	Sm-147	Re-187	Os-191m	Pt-193m	Pt-197m
Th-232	Th-Nat	U-235	U-238	U-Nat.				

* International Atomic Energy Agency (Vienna). Technical Reports Series No. 15—A Basic Toxicity Classification of Radionuclides (1963).

† An alternative classification has been suggested by K. Z. Morgan, W. S. Snyder and M. R. Ford. *Health Physics*, **10** (3), 151, 1964.

‡ The International Atomic Energy Agency refers to Groups 1 to 4 as " High Toxicity ", " Medium-Toxicity—Upper Sub-Group A ", " Medium Toxicity—Lower Sub-Group B " and " Low Toxicity " respectively.

Classification of Laboratories

(46) For convenience in discussion, laboratories designed for handling low levels of radioactivity are described as Type 1, for intermediate levels as Type 2, and for high levels as Type 3. The amount of any given radionuclide that can be handled at one time will vary according to the type of laboratory available, and the type of laboratory suitable for any given amount of material will vary with its toxicity. Table 2 gives a classification of types of laboratories required for various amounts of radionuclides in the groups defined in Table 1. It is unlikely that, at present, there will be the need for a Type 3 laboratory for clinical work in hospitals.

Table 2. Classification of Laboratories for Handling Radionuclides

Group of Radionuclide	Type of laboratory required for levels of activity specified below		
	Type 1	Type 2	Type 3
1	< 10 μCi	10 μCi to 1 mCi	> 1 mCi
2	< 1 mCi	1 mCi to 100 mCi	> 100 mCi
3	< 100 mCi	100 mCi to 10 Ci	> 10 Ci
4	< 10 Ci	10 Ci to 1000 Ci	> 1000 Ci

Modifying factors (see text)	Factors
Simple storage	× 100
Very simple wet operations (e.g. preparation of aliquots of stock solutions)	× 10
Normal chemical operations (e.g. analysis, simple chemical preparations)	× 1
Complex wet operations (e.g. multiple operations, or operations with complex glass apparatus)	× 0.1*
Simple dry operations (e.g. manipulation of powders) and work with volatile radioactive compounds	× 0.1*
Dry and dusty operations (e.g. grinding)	× 0.01*

(47) It is apparent that no exact definition of these requirements is given in Table 2. To attempt to do so would give a misleading impression of precision, because many factors must be considered that do not appear in the table. Experienced people can work safely with equipment which might be dangerous in the hands of beginners, and no weight has been given to difficulties of manipulation caused by the shielding and remote handling required by γ-emitters.

(48) Numerical values can be assigned to certain additional factors, and this is done by applying the " modifying factors " given beneath Table 2. If, for example, normal chemical operations are to be carried out with up to 10 mCi of a Group 2 radionuclide, a Type 2 laboratory would be required. However, 100 mCi (i.e. 10 mCi × modifying factor 10) of such material could be used

* These factors could be increased by one or more orders of magnitude if the operations are carried out in closed boxes.

CONTAMINATION LIMITS

Maximum acceptable contamination limits are listed in the table below. If these limits are exceeded corrective measures will be taken.

Surface Contamination Limits (uCi/m^2)

Contaminant	Alpha		Beta Gamma	
Category	Fixed	Removable	Fixed	Removable
Restricted Areas				
floors	0.1	0.01	1	0.1
clothing	0.1	Bkg	1	0.1
protective enclosure	*	*	*	*
other surfaces	1	0.1	10	1
Unrestricted Areas	0.01	0.001	0.1	0.01
skin	0.01	Bkg	0.1	Bkg

---

*As low as reasonably achievable and controlled to prevent spread of contamination into adjacent areas (e.g., glove boxes, hoods, etc.).

NOTE: $1\ uCi/m^2 = 10^{-2}\ uCi/100\ cm^2 = 22{,}200\ dpm/100cm^2$.

EMERGENCY AND DECONTAMINATION PROCEDURES

A. General Guidelines

Even in a well planned and executed program the possibility exists that incidents will occur. Recognition of this fact requires that suitable emergency procedures must be prepared before hand and must be made known to all persons potentially involved. Each user should give consideration to the nature of possible accidents and be familiar with the following procedures.

B. Missing Sources

When a source is suspected of or confirmed to be missing

1. Report the facts to the Radiation Safety Officer immediately.

2. If the source was stolen, notify the local law enforcement agency as soon as possible.

The Radiation Safety Officer will determine what further action must be taken.

C. Sealed Source Dislodgements

If a sealed source such as in a gauging device or beam calibrator becomes dislodged from its shielding assembly or becomes stuck in the "On," "Shutter Open' or "Source Exposed" position,

1. Do not attempt to replace the source into its shielding assembly or move the device from its location.

2. Immediately clear and secure the area to prevent accidental exposure to the radiation field.

3. Establish a boundary around the device at 2mR/hr and prevent personnel from entering the area.

4. Notify the Radiation Safety Officer immediately.

Upon consideration of the incident scenario, the Radiation Safety Officer will initiate and direct the appropriate corrective actions.

D. Minor Radioactive Material Spills

1. Notify all other persons in the room at once.

2. Clear the room of all persons except those needed to deal with spill area.

3. Confine spill immediately. (Use Gloves!)

   a) Liquid spills
   Drop absorbent paper on spill

   b) Dry spills (powders, flakes, etc.)
   Dampen thoroughly, taking care not to spread contamination (use water unless a chemical reaction would release air contaminants, otherwise use oil)

4. Decontaminate

5. Monitor all persons involved in spill and cleaning.

6. Do not resume work in area until a survey is made showing the contamination has been removed or approval of Radiation Safety Officer is obtained.

E. Major Radioactive Material Spills

In general, a spill or accident outside of a hood involving more than 100 microcuries should be required to use this emergency procedure, whether the material spilled is dry or wet form. It is obviously difficult to set a limit which will be significant in all cases, and it is recommended that, when in doubt, the person responsible for the spill
follow the recommended procedure for his own protection and for the protection of others who may be concerned.

1. The room must be vacated immediately, equipment shut off, a warning sign posted on the closed door, and the individual should hold his breath while he is in the room to avoid inhalation of any radioactive particles which may possibly be in the air.

2. The primary responsibility of the individual is the safety of himself and other individuals; possible loss of materials is an entirely secondary consideration. Only such measures for the prevention of spread of the hazard should be undertaken (dropping absorbent cellulose pads for liquids, righting of containers) as can be carried out during the space of time in which the breath can be held before leaving the room. Thereafter entrance to the room shall be allowed only under the supervision of the Radiation Safety Officer or his designate and with suitable precautions.

3. Any clothing suspected of having been contaminated shall be removed immediately, and returned to the room in which the accident occurred, or to a closed radioactive waste container (do not transport through the building).

4. If any of the spilled material may have come in contact with the skin, or any part of the individual's body, a thorough washing and flushing should be done immediately and an emergency shower used, if necessary.

The amount of activity on the person before and after washing should be determined if possible. The amount of material involved in the spill should be ascertained so that this information may be given to the Radiation Safety Officer.

5. As soon as the spill has occurred, assistance should be sought to notify the Radiation Safety Officer:

   a) Radiation Safety Officer, 866-7744 (24 hours).

   b) The supervisor under whom the person is working.

   c) Call the Safety Officer X5123.

   d) A doctor or other medical assistance if necessary because of physical injury - Medical Department X5680 or X5675.

F. Decontamination of Facilities

Decontamination of facilities and equipment will be performed under the supervision of the Radiation Safety Officer or his representative.

Methods of decontamination are essentially the same as for cleaning of any facility or equipment. Good detergents and water are usually suitable for cleaning of most surfaces. More caustic or corrosive solutions may be used for severely contaminated surfaces. More detailed and specific agents and cleaning methods follow.

G. Decontamination of Personnel

When an individual is seriously injured as the result of a laboratory accident, the first consideration should be to seek medical attention. During working hours report to the Medical Department. During off-hours report to Security.

Decontamination of the skin and clothing should be effected immediately. The individual should remove contaminated clothing at once. Thorough washing with soap and water is the best general method for decontamination of the hands and other parts of the body regardless of the contaminant. Specific instructions for washing and additional methods follow. Individuals who are cut by glassware or injured by hypodermic needles should wash the affected part under a strong stream of water immediately. persons swallowing radioactive material should be treated as for poisoning. Vomiting should be induced or material should be removed by stomach pump. In all cases of ingestion bio-assay samples will be required.

PERSONNEL DECONTAMINATION

Method*	Surface	Action	Technique	Advantages	Disadvantages
Soap and water	Skin and hands	Emulsifies and dissolves contaminate.	Wash 2-3 minutes and monitor. Do not wash more than 3-4 times.	Readily available and effective for most radioactive contamination.	Cont[illegible] [illegible]inate washing of other than affected parts may spread contamination.
Soap and water	Hair	Same as above.	Wash several times. If contamination is not lowered to acceptable levels, shave the head and apply skin decontamination methods.		
Lava soap, soft brush, and water	Skin and hands	Emulsifies, dissolves, and erodes.	Use light pressure with heavy lather. Wash for 2 minutes, 3 times. Rinse and monitor. Use care not to scratch or erode the skin. Apply lanolin or hand cream to prevent chapping.	Same as above.	Continued washing will abrade the skin.
Tide or other detergent (plain)	Same as above.	Same as above.	Make into a paste. Use with additional water with a mild scrubbing action. Use care not to erode the skin.	Slightly more effective than washing with soap.	Will defat and abrade skin and must be used with care.

*Begin with the first listed method and then proceed step by step to the more severe methods, as necessary.

PERSONNEL DECONTAMINATION--Continued

Method*	Surface	Action	Technique	Advantages	Disadvantages
Mixture of 50% Tide and 50% corn-meal	Skin and hands	Emulsifies, dissolves, and erodes.	Make into a paste. Use with additional water with a mild scrubbing action. Use care not to erode the skin.	Slightly more effective than washing with soap.	Will defat and abrade skin and must be used with care.
5% water solution of a mixture of 30% Tide, 65% Calgon, 5% Carbose (carboxymethyl cellulose)	Same as above.	Same as above.	Use with water. Rub for a minute and rinse.	Same as above.	Same as above.
A preparation of 8% Carbose, 3% Tide, 1% Versene, and 88% water homogenized into a cream.	Same as above.	Same as above.	Use with additional water. Rub for 1 minute and wipe off. Follow with lanolin or hand cream.	Same as above.	Same as above.
Titanium dioxide paste. Prepare paste by mixing precipitated titanium dioxide (a very thick slurry, never permitted to dry) with a small amount of lanolin. If not successful, go on to next step.	Skin, hands, and extremities. Do not use near face or other body openings.	Same as above.	Work the paste into the affected area for 2 minutes. Rinse and wash with soap and warm water. Monitor.	Removes contamination lodged under scaly surface of skin. Good for heavy surface contamination of skin.	If left on too long will remove skin.

*Begin with the first listed method and then proceed step by step to the more severe methods, as necessary.

Method*	Surface	Action	Technique	Advantages	Disadvantages
Mix equal volumes of a saturated solution of potassium permanganate and 0.2 N sulfuric acid. (Saturated solution of $KMnO_4$ is 6.4 grams per 100 ml of H_2O.) Continue with next step.	Skin, hands, and extremities. Do not use near face or other body openings.	Dissolves contaminant absorbed in the epidermis.	Pour over wet hands, rubbing the surface and using hand brush for not more than 2 minutes. Rinse with water.	Superior for skin contamination. May be used in conjunction with titanium oxide.	Will remove a layer of skin if in contact with the skin for more than 2 minutes.
Apply a freshly prepared 5% solution of sodium acid sulfite. (Solution made by dissolving 5 gm of $NaHSO_3$ crystals in 100 ml distilled water.)	Same as above.	Removes the permanganate stain.	Apply in same manner as above. Apply for not more than 2 minutes. The above procedure may be repeated. Apply lanolin or hand cream when completed.		Same as above.
Flushing	Eyes, ears, nose, and mouth	Physical removal by flushing.	Roll back the eyelid as far as possible, flush with large amounts of water. If isotonic irrigants are available, obtain them without delay. Apply to eye continually and then flush with large amounts of water.	If used immediately will remove contamination. May also be used for ears, nose, and throat.	When using for nose and mouth, contaminated individual should be warned not to swallow the rinses.

*Begin with the first listed method and then proceed step by step to the more severe methods, as necessary.

PERSONNEL DECONTAMINATION--Continued

Method*	Surface	Action	Technique	Advantages	Disadvantages
Flushing (Cont'd)			(Isotonic irrigant [0.9% NaCl solution]: 9 grams NaCl in beaker, fill to 1000 cc with water.) Can be purchased from drug suppliers, etc. Further decontamination should be done under medical supervision.		
Flushing	Wounds	Physical removal by flushing.	Wash would with large amounts of water and spread edges to stimulate bleeding, if not profuse. If profuse, stop bleeding first, clean edges of wound, bandage, and if any contamination remains, it may be removed by normal cleaning methods, as above.	Quick and efficient if wound not severe.	May spread contamination to other areas of body if not done carefully.
Sweating	Skin of hands and feet	Physical removal by sweating.	Place hand or foot in plastic glove or booty. Tape shut. Place near source of heat for 10-15 minutes or	Cleansing action is from inside out. Hand does not dry out.	If glove or booty is not removed shortly after profuse sweating starts and part washed with soap

*Begin with the first listed method and then proceed step by step to the more severe methods, as necessary.

PERSONNEL DECONTAMINATION--Continued

Method*	Surface	Action	Technique	Advantages	Disadvantages
Sweating (Cont'd)			until hand or foot is sweating profusely. Remove glove and then wash using standard techniques. Or gloves can be worn for several hours using only body heat.		and water immediately, contamination may seep into the pores.

AREA AND MATERIAL DECONTAMINATION

Method*	Surface	Action	Technique	Advantages	Disadvantages
Vacuum cleaning	Dry surfaces	Removes contaminated dust by suction.	Use conventional vacuum technique with efficient filter.	Good on dry, porous surfaces. Avoids water reactions.	All dust must be filtered out of exhaust. Machine is contaminated.
Water	All nonporous surfaces (metal, painted, plastic, etc.).	Dissolves and erodes.	<u>For large surfaces</u> Hose with high-pressure water at an optimum distance of 15 to 20 feet. Spray vertical surfaces at an angle of incidence of 30° to 40°; work from top to bottom to avoid recontamination. Work upwind to avoid spray.	All water equipment may be utilized. Allows operation to be carried out from a distance. Contamination may be reduced by 50%. Water equipment may be used for solutions of other decontaminating agents.	Drainage must be controlled. Not suitable for porous materials. Oiled surfaces cannot be decontaminated. Not applicable on dry contaminated surfaces (use vacuum); not applicable on porour surfaces such as wood, concrete.

*Begin with the first listed method and then proceed step by step to the more severe methods, as necessary.

AREA AND MATERIAL DECONTAMINATION--Continued

Method*	Surface	Action	Technique	Advantages	Disadvantages
Water (Cont'd)			Determine cleaning rate experimentally, if possible; otherwise, use a rate of 4 square feet per minute.		canvas, etc. Spray will be contaminated.
	All surfaces	Dissolves and erodes.	For small surfaces Blot up liquid and handwipe with water and appropriate commercial detergent.	Extremely effective if done immediately after spill and on nonporous surfaces.	Of little value i the decontamination of large areas, longstanding contaminants and porous surfaces.
Steam	Nonporous surfaces (especially painted or oiled surfaces).	Dissolves and erodes.	Work from top to bottom and from upwind. Clean surface at a rate of 4 square feet per minute. The cleaning efficiency of steam will be greatly increased by using detergents.	Contamination may be reduced approximately 90% on painted surfaces.	Steam subject to same limitations as water. Spray hazard makes the wearing of waterproof outfits necessary.
Detergents	Nonporous surfaces (metal, painted, glass, plastic, etc.).	Emulsifies contaminant and increases wetting power of water and cleaning efficiency of steam.	Rub surface 1 minute with a rag moistened with detergent solution then wipe with dry rag; use clean surface of the rag for each application. Use a power rotary brush with	Dissolves industrial film and other materials which hold contamination. Contamination may be reduced by 90%.	May require personal contact with surface. May not be efficient on longstanding contamination.

*Begin with the first listed method and then proceed step by step to the more severe methods, as necessary.

Method*	Surface	Action	Technique	Advantages	Disadvantages
Detergents (Cont'd)			pressure feed for more efficient cleaning. Apply solution from a distance with a pressure proportioner. Do not allow solution to drip onto other surfaces. Mist application is all that is necessary.		
Complexing agents	Nonporous surfaces (especially unweathered surfaces; i.e., no rust or calcareous growth).	Forms soluble complexes with contaminated material.	Complexing agent solution should contain 3% (by weight) of agent. Spray surface with solution. Keep surface moist 30 minutes by spraying with solution periodically. After 30 minutes, flush material off with water. Complexing agents may be used on vertical and overhead surfaces by adding chemical foam (sodium carbonate or aluminum sulfate).	Holds contamination in solution. Contamination may be reduced by 75% in 4 minutes on unweathered surfaces. Easily stored; carbonates and citrates are nontoxic, noncorrosive.	Requires application for 5 to 30 minutes. Little penetrating power; of small value on weathered surfaces.

*Begin with the first listed method and then proceed step by step to the more severe methods, as necessary.

AREA AND MATERIAL DECONTAMINATION--Continued

Method*	Surface	Action	Technique	Advantages	Disadvantages
Acid mixtures (Cont'd)			gal. water		
Caustics: lye (sodium hydroxide) calcium hydroxide potassium hydroxide	Painted surfaces (horizontal).	Softens paint (harsh method).	Allow paint-remover solution to remain on surface until paint is softened to the point where it may be washed off with water. Remove remaining paint with long-handled scrapers. Typical paint remover solution: 10 gal. water, 4 lb lye, 6 lb boiler compound 0.75 lb cornstarch.	Minimum contact with contaminated surfaces. Easily stored.	Personal hazard (will cause burns). Reaction slow; thus, it is not efficient on vertical or overhead surfaces. Should not be used on aluminum or magnesium.
Trisodium phosphate	Painted surfaces (vertical, overhead).	Softens paint (mild method).	Apply hot 10% solution by rubbing and wiping procedure (see Detergent).	Contamination may be reduced to tolerance in one or two applications.	Destructive effect on paint. Should not be used on aluminum or magnesium.
Abrasion	Nonporous surfaces.	Removes surface.	Use conventional procedures, such as sanding, filing, and chipping; keep surface damp to avoid dust hazard.	Contamination may be reduced to as low a level as desired.	Impracticable for porous surfaces because of penetration by moisture.
Sandblasting	Nonporus surfaces.	Removes surfaces.	Keep sand wet to lessen spread of contamination.	Practical for large surface areas.	Contamination spread over area must be removed.

*Begin with the first listed method and then proceed step by step to the more severe methods, as necessary.

AREA AND MATERIAL DECONTAMINATION--Continued

Method*	Surface	Action	Technique	Advantages	Disadvantages
Sandblasting (Cont'd)			Collect used abrasive or flush away with water.		Contaminated dust is personnel hazard.
Vacuum blasting	Porous and non-porous surfaces.	Removes surface; traps and controls contaminated waste.	Hold tool flush to surface to prevent escape of contamination.	Contaminated waste ready for disposal. Safest abrasion method.	Contamination of equipment.

*Begin with the first listed method and then proceed step by step to the more severe methods, as necessary.

BASIC RULES OF RADIONUCLIDE LAB CONDUCT

For Laboratories Where Material in Unsealed Form Is Used

1. Plan in detail and make dummy runs before inaugurating new procedures.

2. Neatness in the laboratory is of PRIME IMPORTANCE. Contamination can be reduced and controlled effectively by proper organization and work layout.

3. Work areas should be covered with absorbent paper and kept free of materials not required for work at hand. Equipment NOT in use should be decontaminated and stored elsewhere.

4. Hands should be washed before eating or leaving the laboratory area. Gloves should be worn when handling material which may contaminate the hands.

5. NO eating, drinking or smoking in the radionuclide laboratory. NO food preparation. Radionuclides must NOT be stored in the same refrigerator with foodstuffs.

6. Use manual pipetting for radionuclides solutions. Pipetting by mouth is NOT permitted.

7. Transporting significant quantities of radioactive liquids shall be done in secondary containers containing enough absorbent material to completely contain the liquid if spilled.

8. Keep radioactive work organized and separate--DO NOT track contamination into non-radioactive areas.

9. Return radioactive materials to storage as soon as they are no longer needed.

10. Significant radioactive waste should be immediately disposed of in the radioactive waste containers.

11. Personnel should wear protective coat or apron which should be changed if contaminated.

12. Give immediate attention to spills.

13. In Emergencies contact the:

Radiation Safety Officer "X5222"

If not immediately available, call X5555
and ask for an emergency page.

SIGNS AND LABELS

Radiation warning signs and labels will be provided for all areas, rooms and storage containers as required by 10CFR20.203 and 10CFR20.204.

RESTRICTED AREAS

Administrative control is used to prevent unauthorized entrance into restricted areas. Restricted areas are areas where: (1) there is a reasonable probability that any individual could receive a dose to the whole body, blood forming organs, lens of the eyes or gonads in excess of 0.5rems in any year. (2) Where, if an individual were continuously present in an area, could result in his receiving a dose in excess of 2mrems in any one hour. (3) Where, if an individual were continuously present in the area, could result in his receiving a dose in excess of 100 mrems in any seven consecutive days. (4) Where the air born concentration averaged over a period not greater than one year exceeds the limit specified in Appendix "B", Table 2, Part 2 10CFR20.

Unauthorized entrance to restricted areas shall be controlled by administrative control or by physically securing the area.

Bioassays for Use of Unsealed Sources in Open Laboratories

The following bioassay schedules are based upon investigation levels for each radionuclide, the probability of an incorporation of an investigation level, the ease of detection and the type of procedures in which these radionuclides are used. Similar principles will be applied to other radionuclides. Additional bioassays will be performed when indicated by findings of surface contamination or airborne contamination. A bioassay will be performed immediately whenever it is suspected that there has been an intake of an investigation level or larger quantity.

Radionuclide	Use Level	Frequency	Method
H-3	10mCi < A < 100 mCi	Quarterly	Urinalysis
	100mCi < A	Within 1 week following use	Urinalysis
I-123,	A < 1mCi		
I-125 & I-131	1mCi < A < 100mCi	Weekly	Direct thyroid count
	100mCi < A	Within 1 day following each use	

When bioassay results indicate that 25% of the maximum permissible burden for the specific radionuclide is present in a critical organ, the working situation will be evaluated with the objective of reducing intake of the by-product material. Where a maximum permissible burden is found in a critical organ, work will be suspended immediately and procedures will be evaluated and modified where necessary to reduce intake of by-product material to a level as low as practicable.

TRANSPORTATION OF RADIOACTIVE MATERIAL

Radioactive material carried in public areas or which are offered to private, contract or common carriers will be packaged, marked and labeled and shipping documents will be prepared as required by applicable DOT regulations. All USNRC and DOT regulations regarding the transportation of radioactive material will be followed. When sources are being carried by company personnel and are left unattended, the security requirement in 10CFR20.207 will be satisfied by locking and removing the keys from the vehicle.

LEAK TESTING OF SEALED SOURCES

Sources Requiring Leak Tests

Each sealed source containing radioactive material other than H-3 with a half life greater than 30 days will be tested for leakage and/or contamination at intervals not to exceed 6 months with the following exceptions:

1. Sources designed to emit alpha particles will be leak tested at intervals not to exceed 3 months.

2. Sources containing 100 μCi or less of beta or gamma emitting material or 10 μCi or less of alpha emitting material will not be tested.

3. Sources containing only tritium or radioactive gases will not be tested.

4. Sources in storage will not be tested.

5. Sources for which the NRC has approved a longer leak test interval will be tested at the approved intervals when in use.

Control No. 76966

ID# ____________

SEALED SOURCE INVENTORY AND LEAK TEST RECORD

Radionuclide: ____________________ Quantity: ____________________

Principal Application: ____________________ Mfg. and Model No. ____________________

Date Acquired: ____________________ Serial No. ____________________

Owned by: ____________________ Calibration: ____________ On: ____________

Date	Assigned To	Room & Bldg.	Leak Test Results µCi	Method	Interlock Check	Next Test Due	By

RADIATION SAFETY SERVICES, Inc.
827 Simpson St.
Evanston, Illinois 60201
(312) 866-7744

LEAK TEST SAMPLING INSTRUCTIONS

1. Wear your film badge and/or TLD finger ring.

2. Wear disposable laboratory gloves.

3. With a cotton tipped applicator or filter paper circle, wipe the accessible external surfaces nearest to the source, its fixture, shield, etc., or wherever contamination is likely to accumulate.

   Caution: The source should be left in its shielding while collecting the sample. Avoid placing any part of the body into a direct radiation beam. Use tongs or forceps when possible to avoid unnecessary exposure.

4. Place the sample in a test tube and label with the source identity.

5. Remove the gloves, place in a plastic bag and return with leak test material.

6. Use your survey meter to survey the plastic bag containing the gloves and the test tube containing the wipe. If any contamination is detected with the survey meter, contact RSO at X5222 or page X5555 immediately. If you detect no contamination, dispose of the gloves as ordinary waste and return the wipe to Radiation Safety Office for analysis.

Control No. 76966

LEAK TESTS

Instrumentation

The selection of radiation detection systems utilized in the analysis of leak test samples will include consideration of the radiation emission characteristics of the source. Generally, gamma emitting radionuclides are analyzed with a single or multichannel analyzer utilizing a NaI(Tl) detector. Beta or electron emitters generally are analyzed on a gas flow planchette counter.

Detection Efficiency

Counting efficiencies are calculated using actual counting data from standards traceable to NBS, EPA, etc., standards (see instrument calibration).

$$E = \frac{C_s T_s^{-1} - C_b T_b^{-1}}{A_s f}$$

where C_s = number of counts obtained from the standard

T_s = length of time standard counted

T_b = length of time background counted

A_s = disintegration rate of standard

C_b = number of background counts

f = number of emissions per disintegration

Radionuclide counting efficiencies are calculated as follows and are used when the standard and potential contaminant are the same radionuclide.

$$E = \frac{C_s T_s^{-1} - C_b T_b^{-1}}{Q}$$

where Q = Activity of standard

Minimum Detectable Activity (MDA)

Prior to the analysis of leak test samples the following calculation is performed to determine the counting system's MDA. The MDA must be 0.005 μCi or less (0.001 in the case of radon emanation tests of brachytherapy sources) to be used for leak test analysis.

$$L_d = \frac{k^2}{T_t} + 2k\sigma_b \left(1 + \frac{T_b}{T_t} \right)^{1/2}$$

where L_d = the detection limit of the system (in CPM)

k = the one sided confidence factor for the specified confidence level (1.65 for 95%)

$\sigma_b = \frac{\sqrt{B}}{Tb}$ = standard deviation of the background count

and T_t = Time leak test sample counted

$$MDA = \frac{L_d}{E}$$

Samples which do not exceed Ld should be reported as less than the MDA, specified in microcuries. Samples exceeding L_d contain measurable activity which will be calculated as follows:

$$A_t = \frac{C_t T_t^{-1} - C_b T_b^{-1}}{E}$$

where C_t = Count of the leak test sample

A_t = Activity in the leak test sample

Radon Emanation Sample Analysis

When analysis of radon emanation samples are performed, corrections must be included for the build-up of radon in the sample collection medium and for decay prior to counting.

$$A_t = \frac{\lambda\ (C_t T_t^{-1} - C_b T_b^{-1})\ e^{\lambda Td}}{E(1 - e^{-\lambda Tc})}$$

where λ = the radon decay constant

T_c = length of time sample collected

T_d = delay between collection and counting

Example:

A single channel analyzer with a 2" x 2" NaI (Tl) detector is used to analyze a leak test sample from a cobalt-57 source. A 0.101 μCi cobalt-57 reference standard is counted for one minute yielding 213,436 counts. The background is 1022 counts in five minutes.

$$E = \frac{(213436/1) - (1022/5)}{0.101\mu Ci} = 2.11 \times 10^6 \frac{cpm}{\mu Ci}$$

If the sample is counted for five minutes,

$$L_d = \frac{(1.65)}{5} + \frac{2(1.65)(1022)}{5}^{1/2}\left(1 + \frac{5}{1}\right)^{1/2}$$

$$L_d = 30.3 \text{ cpm over background}$$

and $$MDA = \frac{30.3}{2.11 \times 10^6} = 1.43 \times 10^{-5}\mu Ci \ (95\%)$$

The sample is counted for five minutes and 1325 counts obtained (1325/5 = 265 cpm). Since the background is 204.4 cpm (1022/5) and L_d = 234.7 cpm (30.3 cpm + 204.4) the count exceeds the system's MDA. The sample activity is given by

$$A_t = (265cpm - 30.3cpm)\ (2.11 \times 10^6 \frac{cpm}{\mu Ci})^{-1}$$

$$A_t = 1.11 \times 10^{-4}\mu Ci$$

The conclusion is that the source is leaking but not beyond the limit of $5 \times 10^{-3} \mu Ci$.

Sample Collection

Samples will be collected in accordance with the attached instructions which include appropriate safety precautions.

Sample Disposal

Samples equaling or exceeding L_d will be disposed of as radioactive waste. Samples below L_d will be disposed of as ordinary waste.

Record Keeping

Results of the analysis of leak test samples will include the date, name of person performing the test and the results in units of microcuries. Radon emanation test results will be kept in units of microcuries of radon per 24 hours.

WASTE DISPOSAL

Radioactive waste is picked up routinely upon request by the Radiation Safety Office. Each waste pick up must be accompanied by a copy of the attached waste card. This waste card serves as the basis for the Center's disposal records and must be filled out completely by the user prior to the removal of waste from his laboratory. Dry radioactive waste is collected in the containers described in the attached reprint. Liquid radioactive waste is collected in five gallon polyethelene containers. Gaseous radioactive waste is disposed of by the means of venting into hoods in a fashion so that the concentration to the nearest occupiable areas do not exceed those in 10CFR20, Appendix B, Table I, Column 1, and Table V, Column 1.

Radiation Safety Services, Inc.
RADIOACTIVE WASTE CARD

AUTHORIZED USER ____________________ DATE ____________

DEPT. ________________ ROOM ________ BLDG. ____________

ISOTOPE ____________________ ACTIVITY ________________

" ____________________ " ________________

" ____________________ " ________________

" ____________________ " ________________

" ____

THIS CARD **MUST** ACCOMPANY EVERY DRUM OR JUG OF WASTE OR EVERY **FIVE** TRAYS OF VIALS.

Disp. Inv. # ____________________ Line # ____________________

RECORD KEEPING

All records required as a condition of license or by the rules and regulations of the United States Nuclear Regulatory Commission are kept in a permanant file in the Radiation Safety Office.

FORM NRC-313M-SUPPLEMENT A
(8-78)

U.S. NUCLEAR REGULATORY COMMISSION

TRAINING AND EXPERIENCE
AUTHORIZED USER OR RADIATION SAFETY OFFICER

1. NAME OF AUTHORIZED USER OR RADIATION SAFETY OFFICER	2. STATE OR TERRITORY IN WHICH LICENSED TO PRACTICE MEDICINE
Cindy Bloom	

3. CERTIFICATION

~~SPECIALTY BOARD~~ EDUCATION A	~~CATEGORY~~ DEGREE B	MONTH AND YEAR ~~CERTIFIED~~ C
Colorado College	BA in Physics	June 1978

4. TRAINING RECEIVED IN BASIC RADIOISOTOPE HANDLING TECHNIQUES

FIELD OF TRAINING A	LOCATION AND DATE(S) OF TRAINING B	TYPE AND LENGTH OF TRAINING: LECTURE/LABORATORY COURSES (Hours) C	TYPE AND LENGTH OF TRAINING: SUPERVISED LABORATORY EXPERIENCE (Hours) D
a. RADIATION PHYSICS AND INSTRUMENTATION	A Colorado College	60	40
	B Radiation Safety Services	40	4000
	C University of Texas	40	8
	D Eberline	40	-
	E Univesity of Lowell	120	
b. RADIATION PROTECTION	Radiation Safety Services	100	8000
	University of Texas	40	8
	University of Lowell	120	
c. MATHEMATICS PERTAINING TO THE USE AND MEASUREMENT OF RADIOACTIVITY	Colorado College	100	40
	Radiation Safety Services	40	500
	University of Texas	40	8
	Eberline	40	-
	" " "	120	
d. RADIATION BIOLOGY	Colorado College	20	-
	Radiation Safety Services	40	500
	University of Texas	40	4
	University of Lowell	120	
e. RADIOPHARMACEUTICAL CHEMISTRY			

5. EXPERIENCE WITH RADIATION. *(Actual use of Radioisotopes or Equivalent Experience)*

ISOTOPE	MAXIMUM AMOUNT	WHERE EXPERIENCE WAS GAINED	DURATION OF EXPERIENCE	TYPE OF USE
See Attached Sheet	See Attached Sheet	Radiation Safety Services, Inc. Evanston, IL	4 years	Operational Health Physics

Cindy Bloc.a Supplement

H-3	300	mCi
C-14	1	mCI
NA-22	2	mCi
P-32	10	mCi
S-35	5	mCi
CA-45	2	mCi
CR-51	5	mCi
FE-55	.5	mCi
CO-60	6500	Ci
NI-63	64	mCi
GA-67	12	mCi
MO-99	2	Ci
TC-99M	100	mCi
RU-106	1	mCi
I-125	5	mCi
I-131	100	mCi
XE-133	10	mCi
BA-133	.28	mCi
CS-137	1320	mCi
YB-169	2	mCi
TL-201	2	mCi
TL-204	.05	mCi
BL-207	.075	mCi
RA-BE	10	mCi
AM-241	.001	mCi

Control No. 76966